Variation in trunk and branch xylem density in French Guiana

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Introduction

- Wood density (D_w) is an easily measured trait that has been shown to be a correlate of mechanical, physiological and life history strategies of trees. It is also an important parameter to estimate aboveground biomass and carbon stocks at regional scales (Muller-Landau 2004; Baker et al. 2004; Patiño et al. 2008).

- In this study, we compare measurements of sapwood density, here referred to as xylem density (D_x), from both the main trunk and branches in three tropical forest plots differing in floristic composition, with three objectives:

1) To describe the relationship between branch and trunk wood density across a large sample of tropical trees
2) To determine if this relationship varies among sites
3) To determine if this relationship is consistent among different angiosperm families

Methods

- As part of the BRIDGE project, we sampled three individuals > 10 cm DBH from every morpho-species found in three 1-ha plots at two sites in French Guiana (Fig. 1).

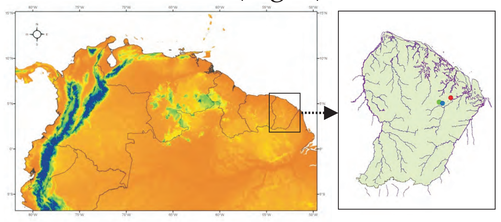

Figure 1. Sampling sites: ●Montagne Tortue ●NH20 (Nouragues) ●NL11 (Nouragues)

- Xylem density (dry mass:fresh volume) was measured in both the trunk and a branch of the sampled trees. A seven-mm diameter core sampler was used to extract recent sapwood from the trunk; for branch sampling, a 1-2 cm diameter twig was cut from the crown of each tree.

- The relationship between xylem density of trunks and branches was examined using standardized major axis regressions (SMA) that were forced through the origin, using the SMATR package of the program R (Falster et al. 2006).

Results

- We sampled 925 trees from the three plots, representing 92 genera in 35 families. More than 95% of the individuals were identified to the genus level, and 86% were identified to the species level.

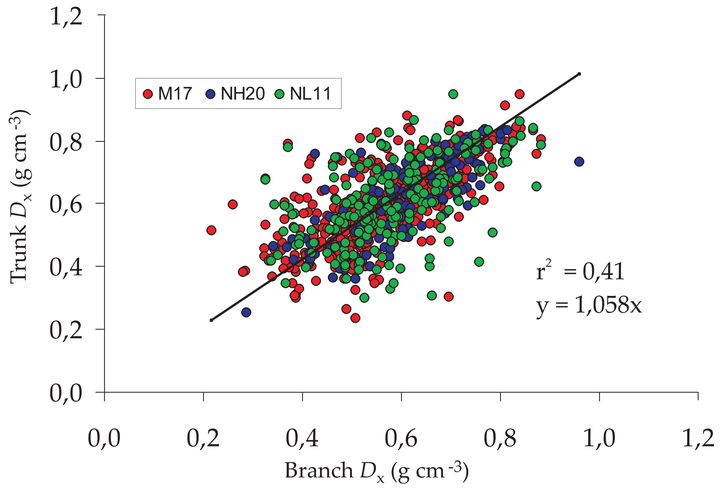

Figure 2. Relationship between branch and trunk D_x in 925 individual trees from three different plots in French Guiana

- Mean branch D_x was 0,607 g cm^{-3} and mean trunk D_x was 0,640 g cm^{-3} .

- The SMA regression between branch and trunk D_x shows that a considerable proportion of the variance in trunk sapwood D_x is not explained by branch D_x ($r^2 = 0.41$; Fig. 2).

- Among the three plots, there was no difference in regression slopes (Likelihood Ratio = 0,09; p = 0,99), nor for elevation of the relationship (Wald = 0,233; p = 0,99). However, the samples from the Nouragues NH20 plot had higher D_x for branches and trunks (Wald = 58,4; p < 0,001).

- An analysis of the four most common families shows similar trends. Within three of four families, the NH20 plot samples had higher D_x for branches and trunks (Fig. 3).

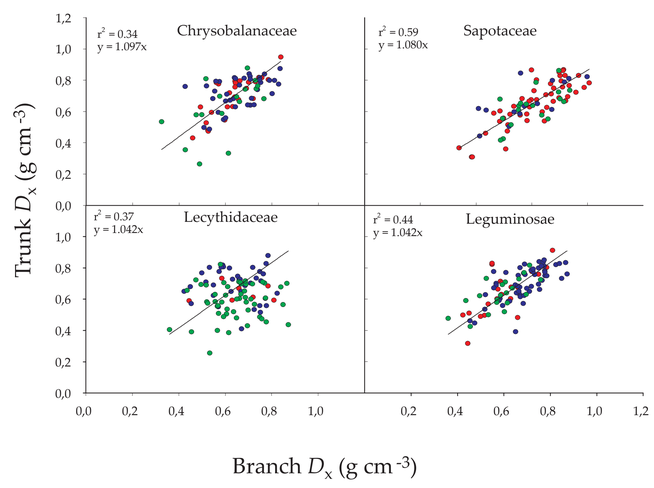

Figure 3. Relationships between branch and trunk D_x for the four most common families across sites.

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For further information...

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- Bridge project: http://ecofog.cirad.fr/Bridge

Discussion and Conclusions

- Our results suggest that the relationship between branch and trunk xylem density for Neotropical trees may not be as strong as has been previously suggested (Swenson & Enquist 2008). We caution against the use of branch density as a surrogate for overall tree density until further studies can be completed.

- In particular, the contribution of individual characteristics, such as tree diameter and height, as well as within-individual variability in branch size or coring location, require further analysis.

- Our results also show that geographic and site differences in community-level wood density are only partly explained by differences in floristic composition. The differences among sites observed in the community dataset were also found within common families. The relative contributions of site floristic composition vs. environmental characteristics such as soil fertility and drought stress remain to be explored.